Exam Date & Time: 24-Sep-2024 (08:30 AM - 10:00 AM)

MANIPAL ACADEMY OF HIGHER EDUCATION

B.Tech I Semester MIDSEM Examination September 2024

FUNDAMENTALS OF ELECTRONICS [ECE 1072]

SCHEME OF VALUATION

(6) Derivation of Drain current

$$I_D = \frac{1}{2}\mu_n C_{ox}\frac{W}{L}\left\{(V_{GS}-V_{TH})V_{DS} - \frac{V_{DS}^2}{2}\right\}$$ → 2 MARKS

V_{DS} - I_D characteristics plot → 1 MARK

Assuming MOSFET in saturation

$$I_D = \frac{1}{2}\times 200\times10^{-6}\times\frac{2}{0.18}(1-0.5)^2$$

$$= 277.77\,\mu A.$$

$$V_{DS} = V_{DD} - I_D R_D = 1.8 - 277.77\times10^{-6}\times5\times10^{3}$$

$$= 0.41\,V$$ → 0.5 MARKS

$$V_{GS} - V_{TH} = 0.5\,V$$

Since $V_{DS} < V_{GS} - V_{TH}$; MOSFET is in TRIODE region. → 0.5 MARKS

(7)

$$I_{D2} = I_{D1}\,2^{(T_2-T_1)/10}$$

$$= 1\times10^{-12}\cdot 2^{(100-20)/10}$$

$$= 256\,pA$$ → 1 MARK

$$I_D = I_{D2}\left(e^{V/\eta V_T} - 1\right)$$

$$= 256\times10^{-12}\left(e^{0.7/2\times\frac{373}{11,600}} - 1\right)$$

$$= 0.013\text{mA}$$ → 1 MARK

$$r_f = \frac{\eta V_T}{I_D + I_{D2}} = \frac{2\times 373}{11,600(0.013\times10^{-3} + 256\times10^{-12})}$$

$$= 4.946\text{K}\Omega$$ → 1 MARK

NOTE: Based on the decimal points taken, diode current and resistance can vary. Please consider the diode current and resistance values with ± (10 to 15)% tolerance while evaluating the answer scripts.

(8)

$$P_z = I_{z_{max}} V_z \Rightarrow I_{z_{max}} = \frac{1}{12} = 83.33\ mA$$

$$V_{IN_{min}} = I_{T_{min}} R + V_z$$

$$= (I_{z_{min}}) \cdot R + V_z = 0.3 \times 10^{-3} \times 200 + 12$$

$$= 12.06\ V \longrightarrow$$ 1.5 MARKS

$$V_{IN_{max}} = I_{T_{max}} \cdot R + V_z$$

$$= (I_{z_{max}}) \cdot R + V_z$$

$$= 0.083 \times 200 + 12$$

$$= 28.6\ V \longrightarrow$$ 1.5 MARKS

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(9) FWR

$$V_p = 220\ V \Rightarrow V_s = \frac{220}{10} = 22\ V$$

$$V_m = 22 \times \sqrt{2}$$

$$\boxed{V_m = 31.113\ V} \quad (\text{peak value})$$

(a) $$V_{dc} = \frac{2V_m}{\pi} = \frac{2 \times 31.113}{\pi}$$

$$\boxed{V_{dc} = 19.807\ V}$$

(b) $$\eta = \frac{P_{dc}}{P_{ac}} = \frac{V_{dc}^2}{V_{rms}^2} = \frac{(19.807)^2}{(22)}$$

$$\boxed{\eta = 81.05\ \%}$$

2 Marks

(c) $$\boxed{PIV = 31.113}$$

(d) $$V_{dc} = \frac{4fCR_L}{1+4fCR_L} V_m$$

$$= \frac{4 \times 50 \times 1m \times 1K \times 31.113}{1 + 4 \times 50 \times 1m \times 1K}$$

$$\boxed{V_{dc} = 30.958\ V}$$

2 Marks

(e) $I_{rms} = \frac{V_{rms}}{R_L} = \frac{22}{1K}$

$I_{rms} = 22mA$ —

(f) $f = 2 \times 50$

$f = 100Hz$ —

1 Marks

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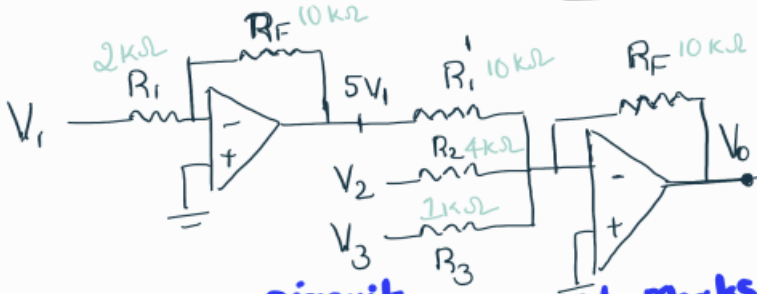
(10) $V_o = 5V_1 - 2.5V_2 - 10V_3$, $R_F = 10K\Omega$



Circuit — 1½ Marks

$\frac{R_F}{R_1} = 5$; $\frac{R_F}{R_1'} = 1$; $\frac{R_F}{R_2} = 2.5$, $\frac{R_F}{R_3} = 10$

$R_1 = \frac{10K}{5}$; $R_1' = 10K\Omega$ $R_3 = \frac{10K}{10}$

$R_1 = 2K\Omega$ $R_2 = \frac{10K}{2.5}$ $R_3 = 1K\Omega$

$R_2 = 4K\Omega$

$R_3 = 1K\Omega$

— 1½ Marks

(11)

$$V_1 = \frac{1}{\mu_n C_{ox}\left(\frac{W}{L}\right) R_S} = 0.45$$

$$V_{GS} = -(0.45 - 0.4) + \sqrt{0.45^2 + 2 \times 0.45\left(\frac{12 \times 10^3 \times 1.8}{17 \times 10^3} - 0.4\right)}$$

$$\boxed{V_{GS} = 0.9429\ V} \longrightarrow$$ 1 MARK

$$I_D = \frac{1}{2} \times 100 \times 10^{-6} \times \frac{4}{0.18} \times (0.9429 - 0.4)^2$$

$$\boxed{I_D = 327.48\ \mu A} \longrightarrow$$ 1 MARK

$V_{DD} = V_G - V_{TH}$ for 'M1' to be in saturation.

$$V_{DD} - I_D R_{D_{max}} = V_{GS} + I_D R_S - V_{TH}$$

$$1.8 - 327.48 \times 10^{-6} R_{D_{max}} = 0.9429 + 0.32748 - 0.4$$

$$\boxed{R_{D_{max}} = 2.838\ k\Omega} \longrightarrow$$ 1 MARK

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(12)

$$A_d = \frac{V_o}{V_1 - V_2} = \frac{10}{1 \times 10^{-3}} = 10{,}000 \longrightarrow$$ 0.5 MARKS

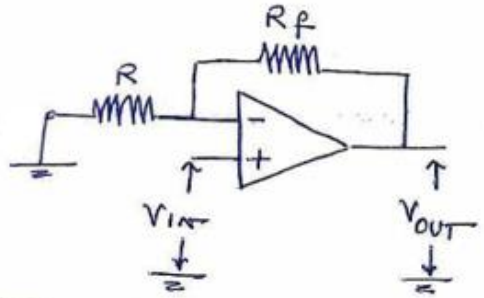
$$A_c = \frac{V_o}{\frac{(V_1 + V_2)}{2}} = \frac{10 \times 10^{-3}}{0.5 \times 10^{-3}} = 20 \longrightarrow$$ 0.5 MARKS

$$CMRR = \left|\frac{A_d}{A_c}\right| = \frac{10{,}000}{20} = 500 \longrightarrow$$ 1 MARK

or

CMRR in dB = 53.98

(13)



NON-INVERTING AMPLIFIER CIRCUIT → 1 MARK

$$A_f = 1 + \frac{R_f}{R}$$

$$5 = 1 + \frac{R_f}{R} \Rightarrow R = \frac{R_f}{4} = 2.5\,k\Omega$$ 1 MARK

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(14)

During both the half cycles of V_{in} diode conducts.

$$\therefore V_o = 10\sin\omega t + 12$$ 1 MARK

$$V_{DC} = 12\,V$$

$$I_{DC} = \frac{12}{1\times10^3} = 12\,mA$$ → 1 MARK